Structural characteristics of winter storms in southern Washington and northern Oregon

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Use of observations for model evaluation and diagnosis

- What structural characteristics of storms are most important to reproduce in numerical models?
- What subset of characteristics can we most reliably observe?
- How do we distinguish between details that are unique to an individual storm versus those that are repeated among a group of storms?

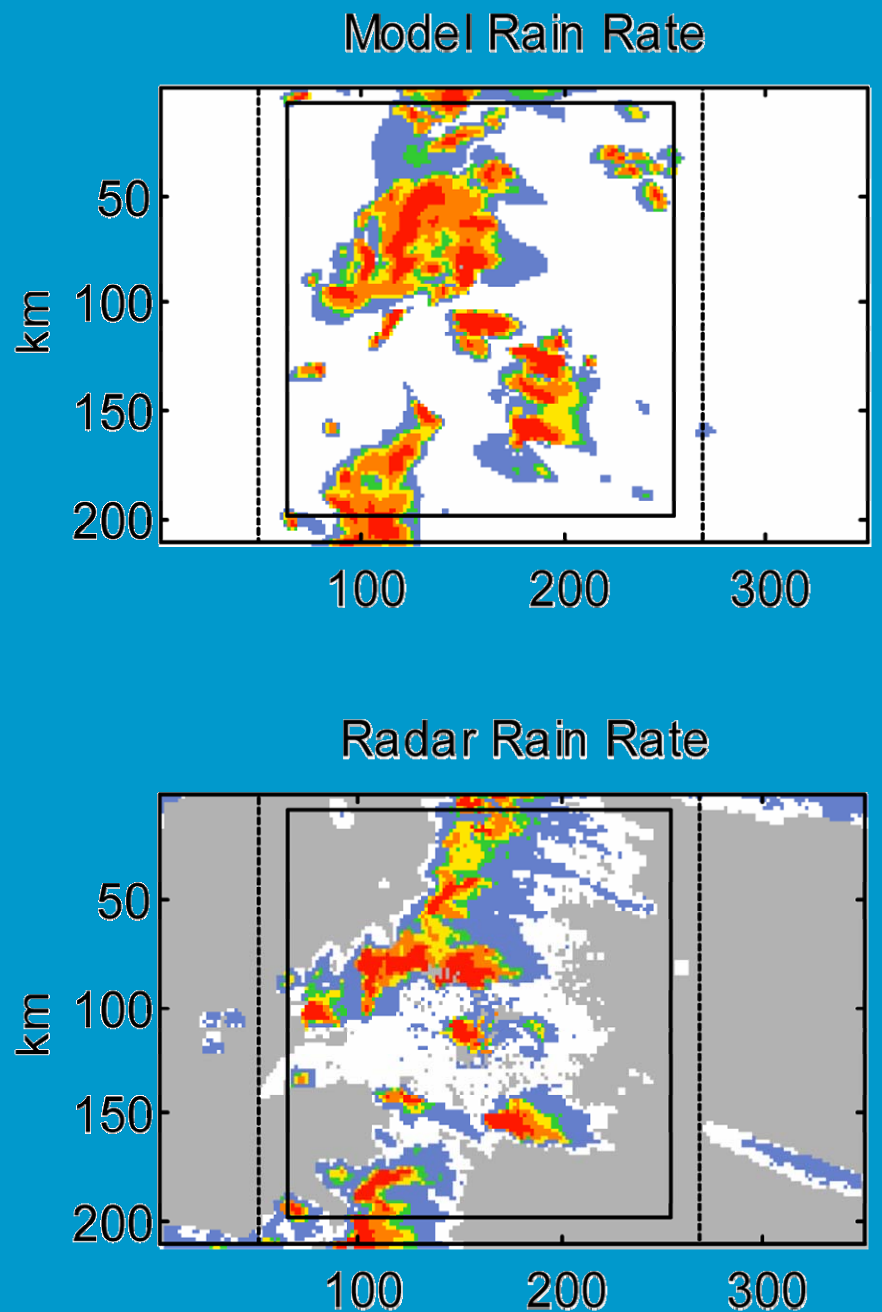
Routine Daily comparison of observations to forecast model output

- Directly comparable products derived from observations and model output yield objective measures of:
  - Confidence in forecast model output for particular storm type
  - Model strengths and weaknesses
  - Evaluation of proposed model changes
  - Diagnosis of error sources

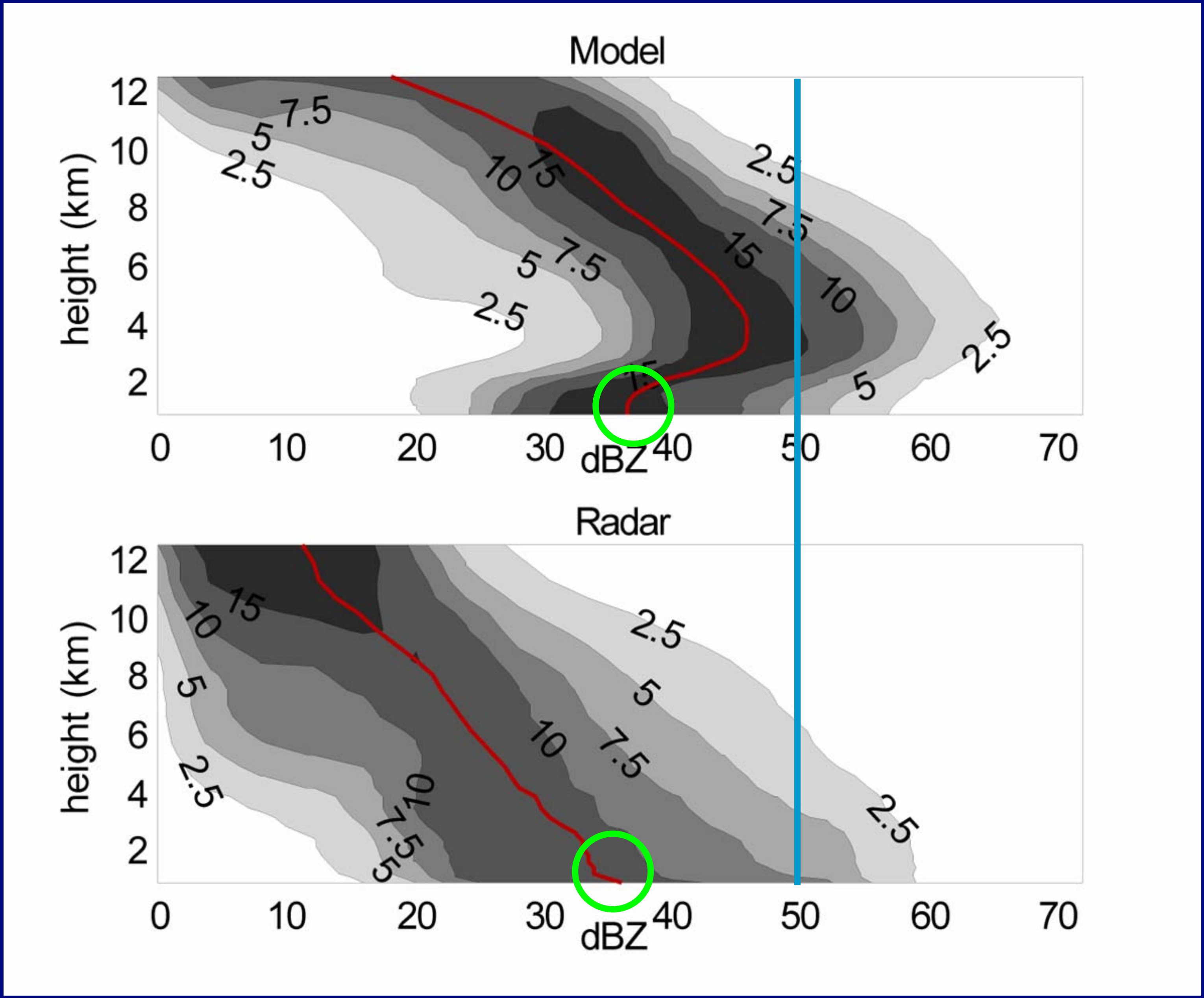
What should the model/observations comparison products look like?

Model to Observation Comparison of Surface Rainfall

1 km cloud resolving model with explicit microphysics (ARPS) of Ft. Worth Texas storm for time=0
(Smedsmo et al, 2005)



Volumetric comparison for accumulated storm totals



Smedsmo et al. (2005)

Evaluation of Model Output must be 3D!

- Surface fields necessary but not sufficient for comparisons

- Operational WSR-88D radar can provide 3D precipitation structure and wind field information
- Supplemental vertically-pointing radar can provide fine-scale information on freezing level and sub-grid scale variability

METEK Inc. Radar in Scholls, OR

Ku-band

(1.25 cm wavelength)

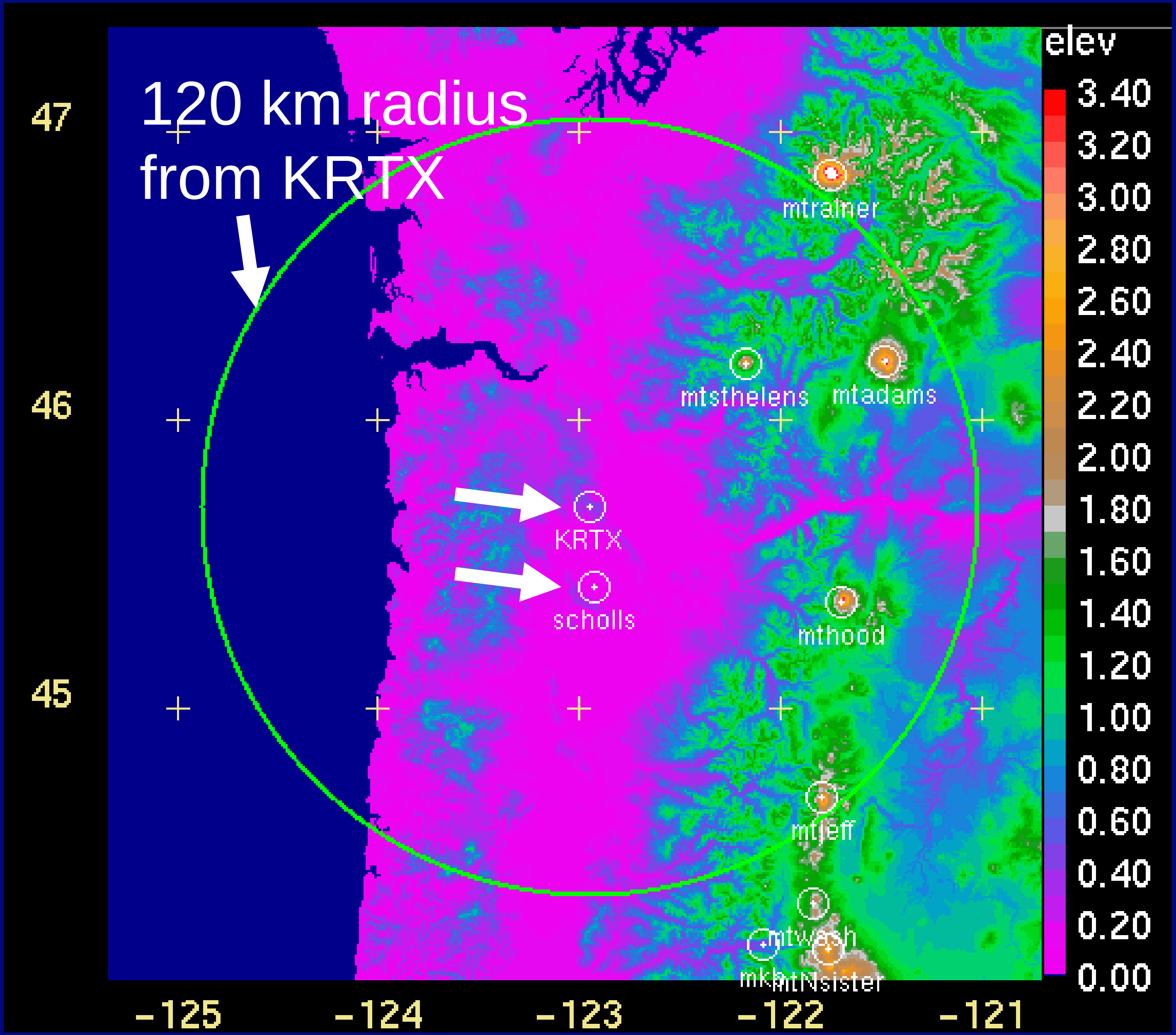
Cost ~ $16K

Resolution ≤ 150 m

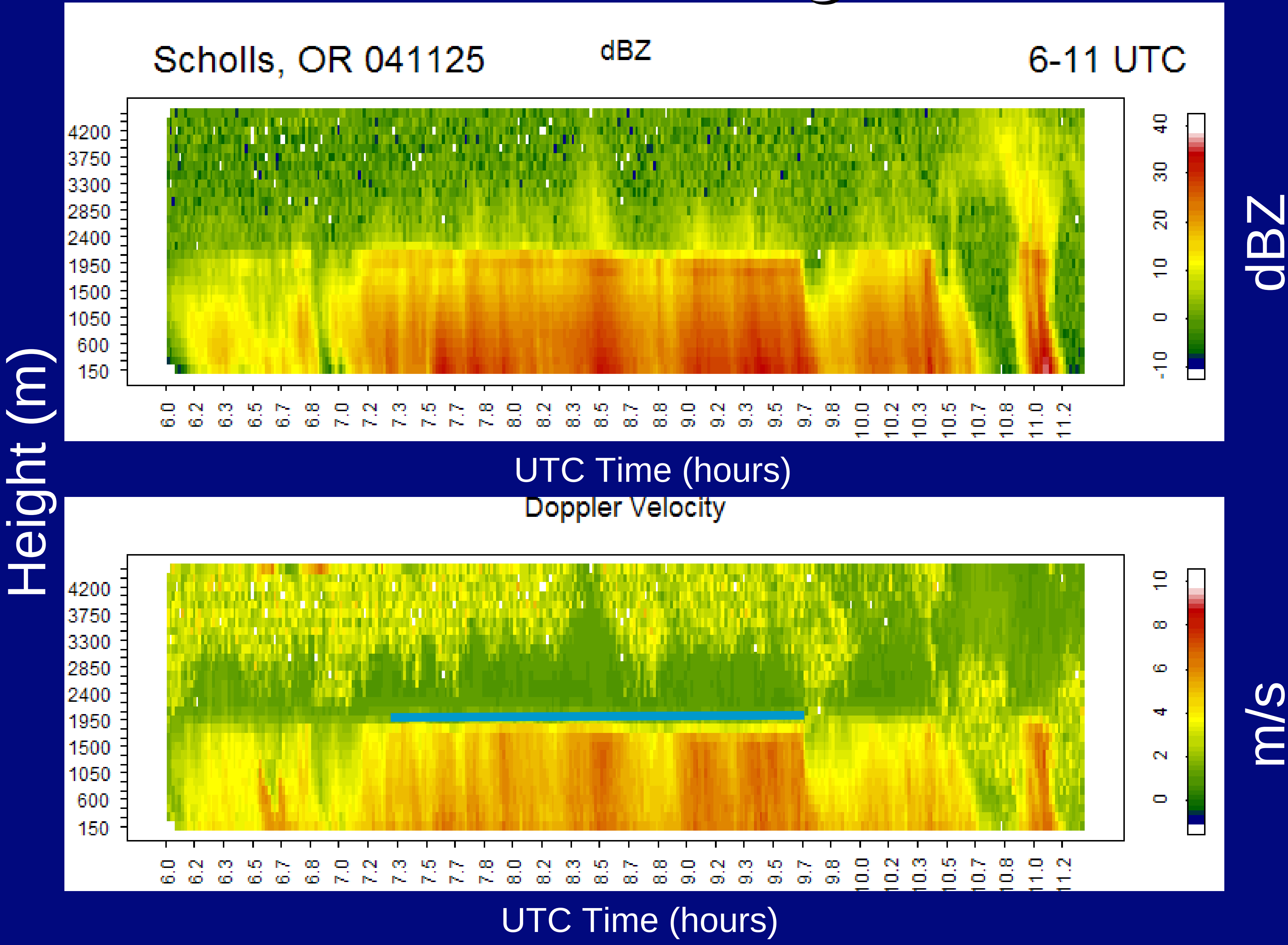
Measurements of:

- Doppler velocity
- dBZ- attenuates in moderate to heavy rain

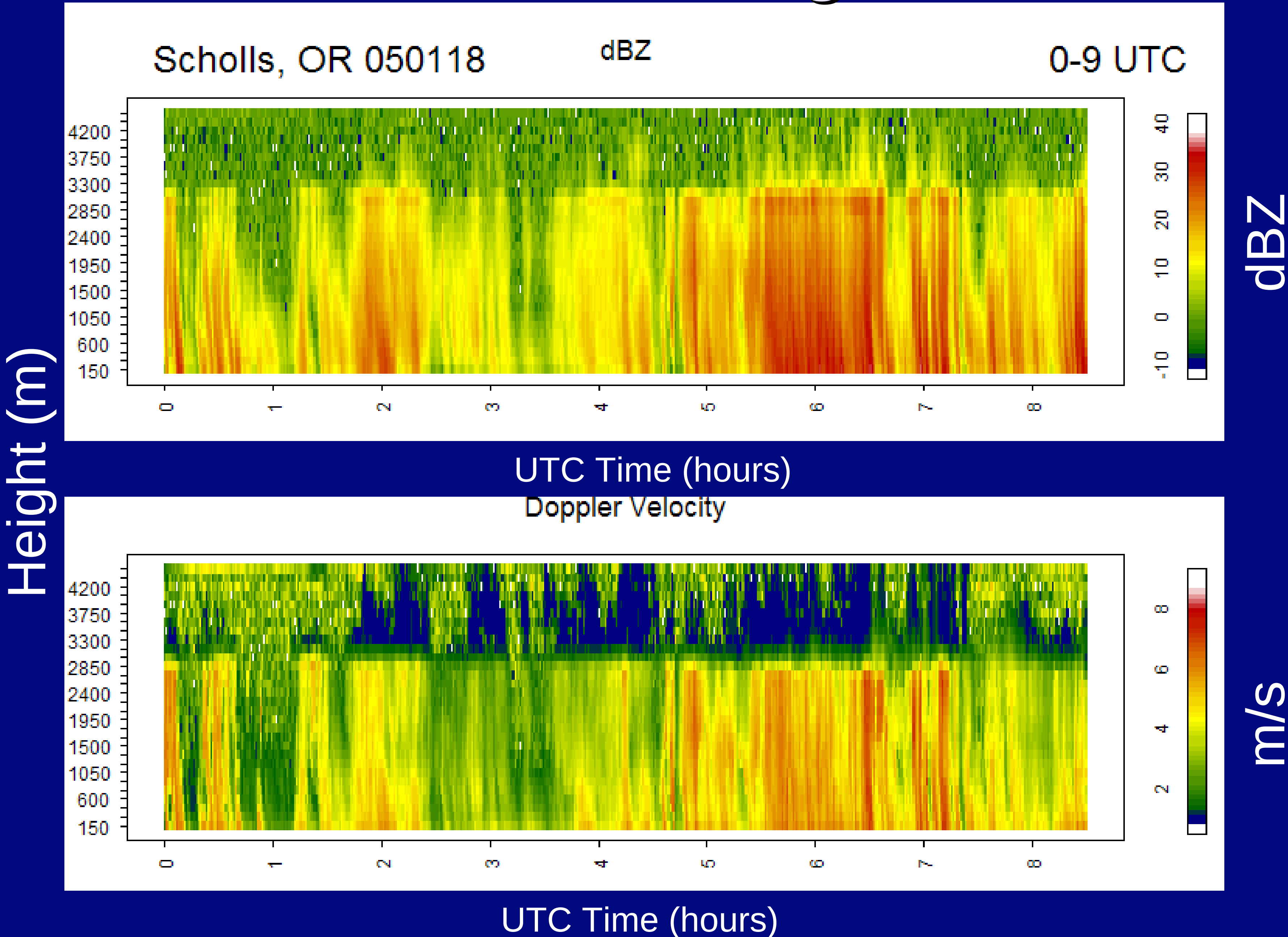
Prototype Concepts in Portland, Oregon Area



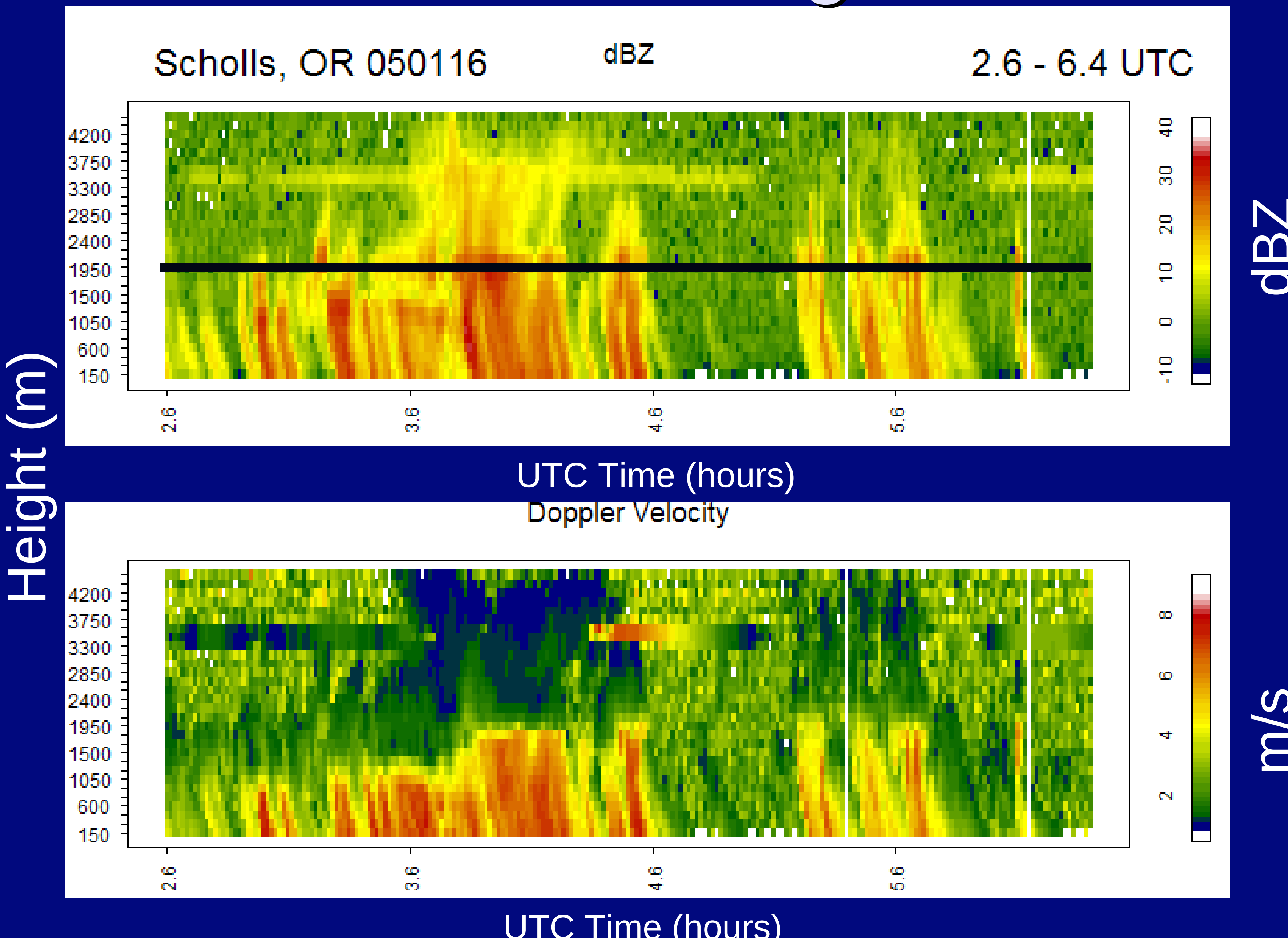
Variable freezing level



Variable freezing level



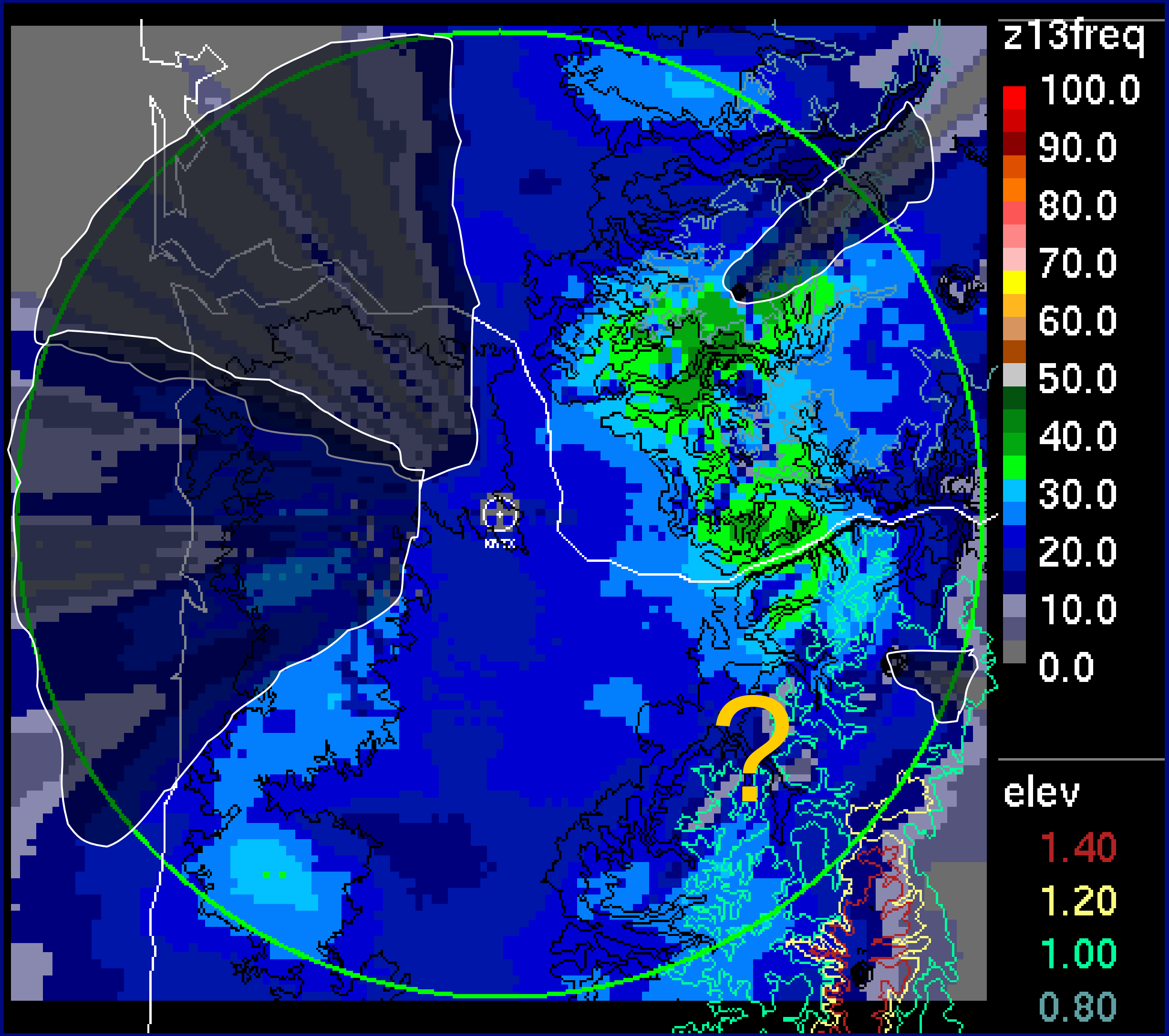
Variable freezing level



What sub area around radar can we use for comparisons?

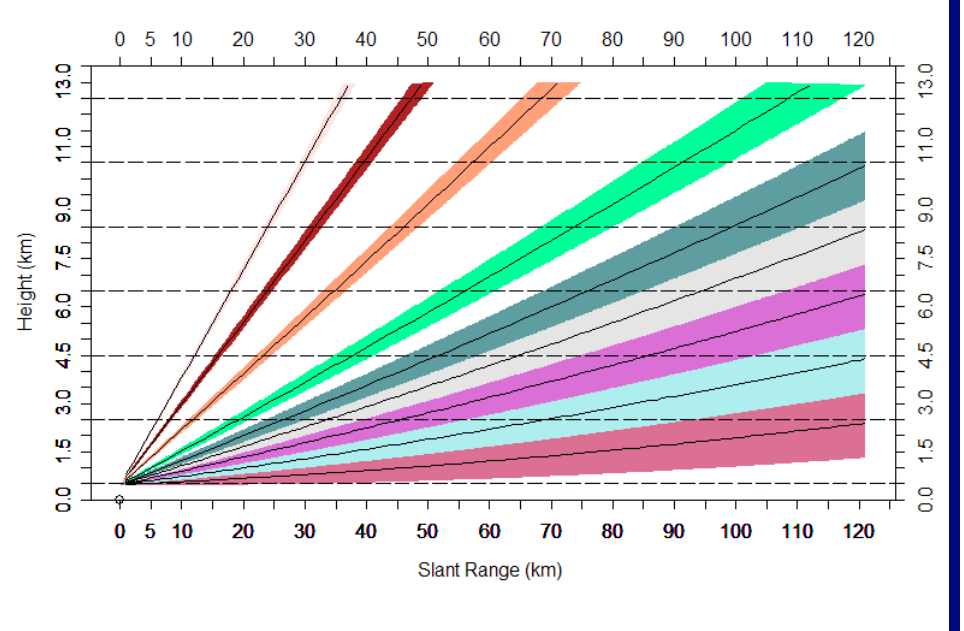
Radar Visibility:

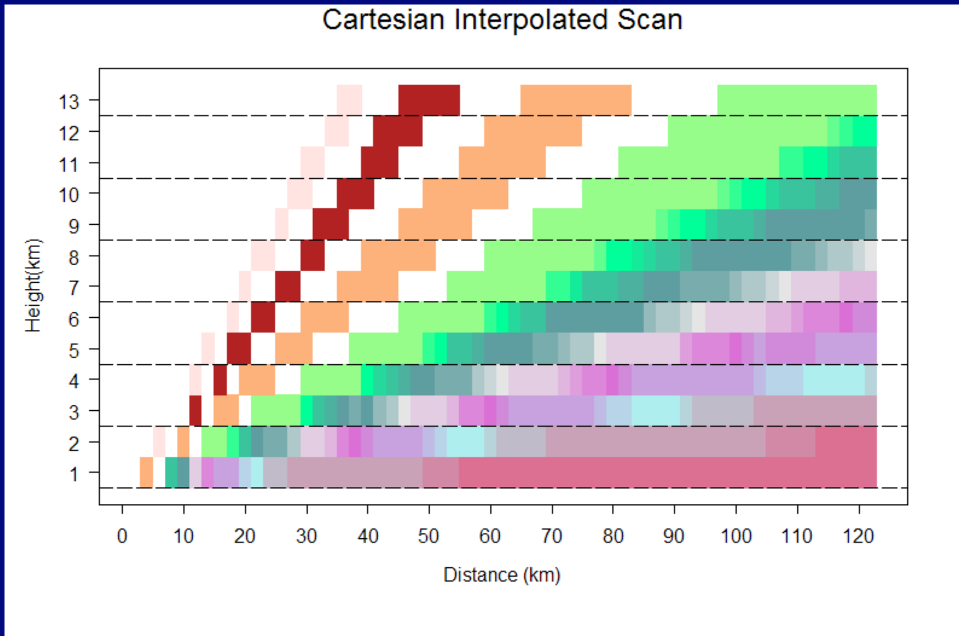
- Total
- Partial
- Blocked



Interpolate Polar Radar Data to Cartesian Coordinate System

WSR-88D Precip Scan



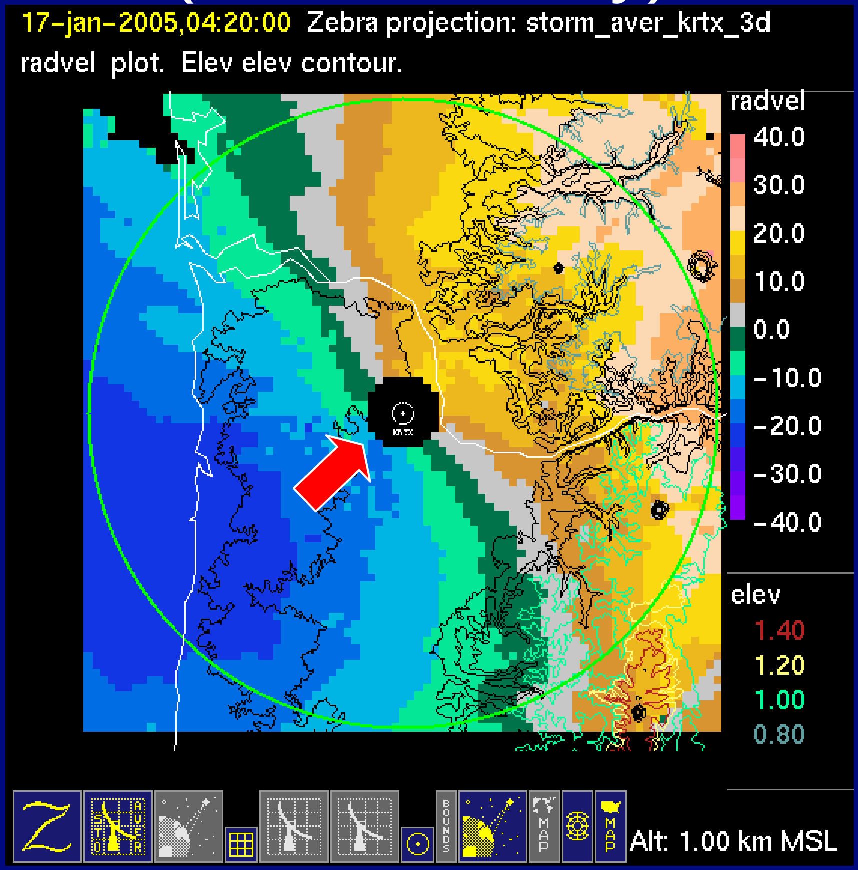


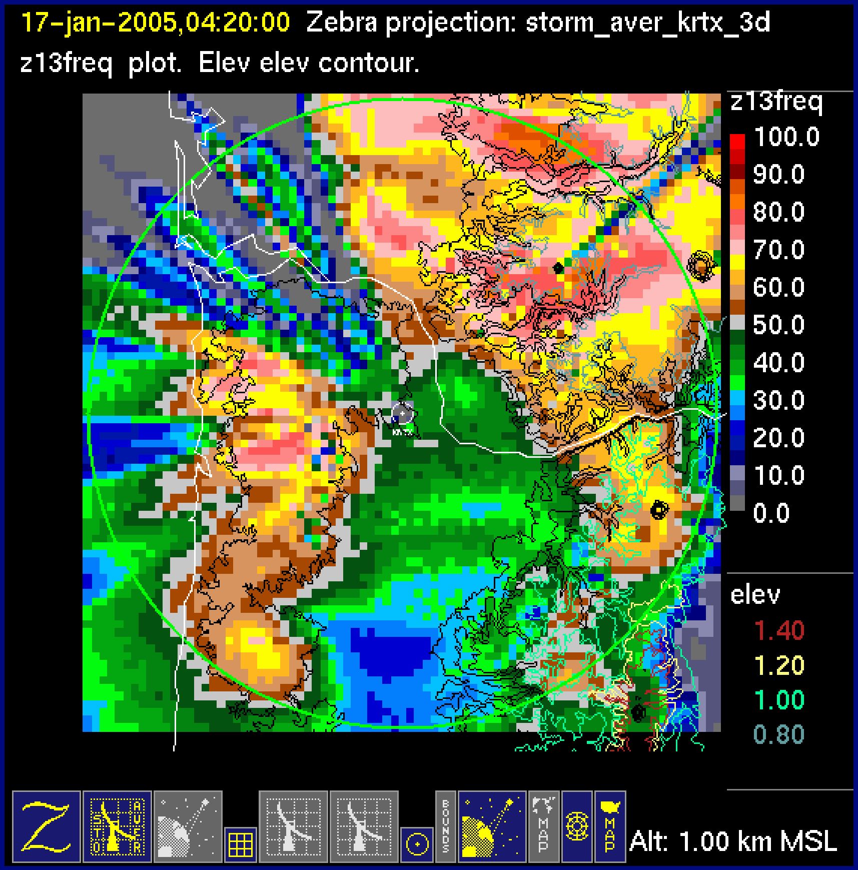
- Spatial coordinates similar to model
- Minimize range dependence of radar data

17 - 18 Jan 2005 storm

Wind Field
(radial velocity)

Freq. of Echo ≥ 13 dBZ

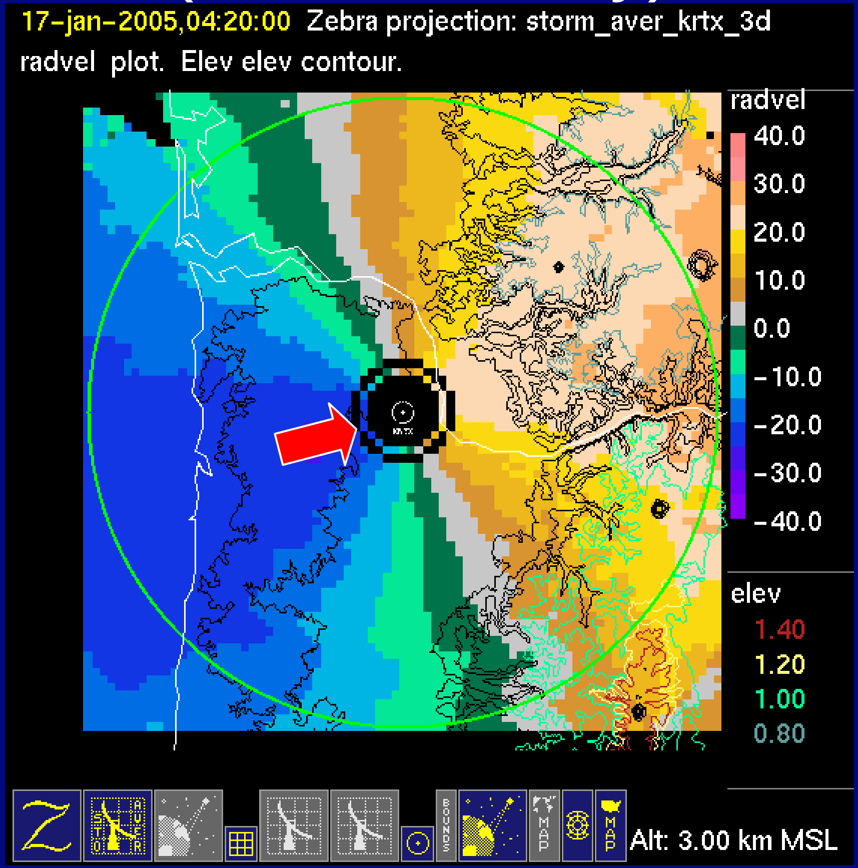




1.0 km altitude

17 - 18 Jan 2005 storm

Wind Field
(radial velocity)



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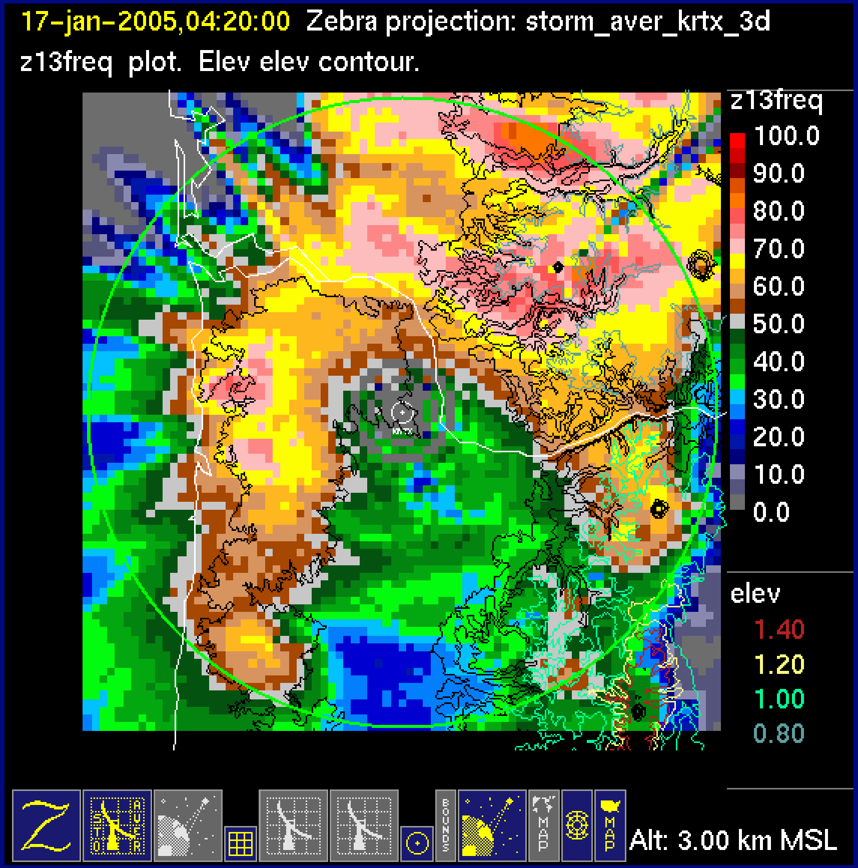
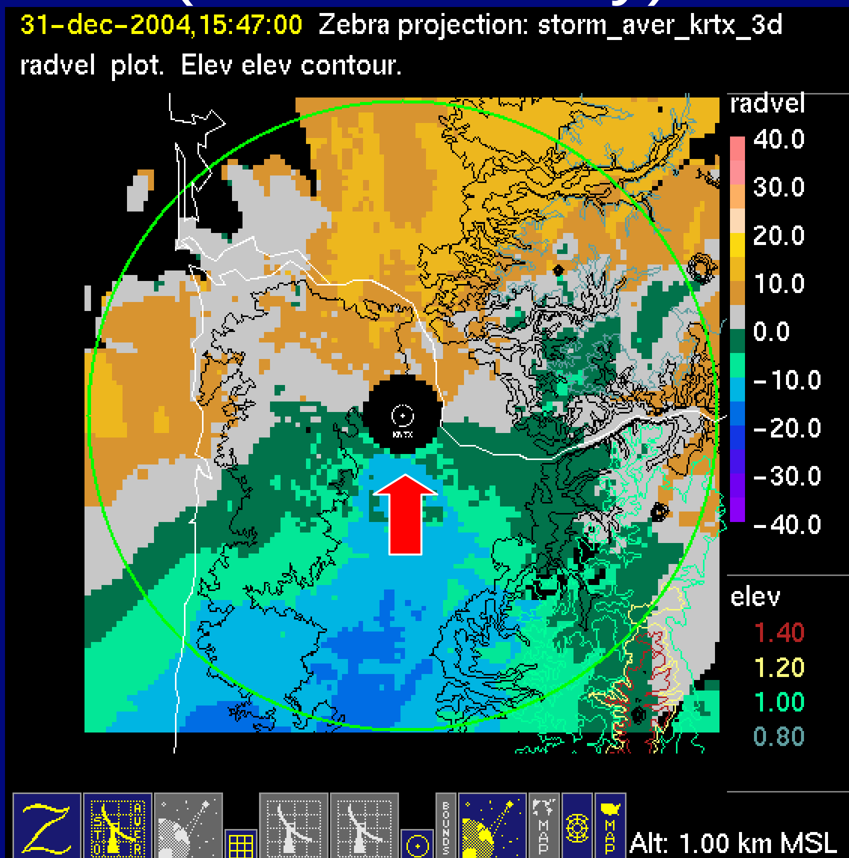


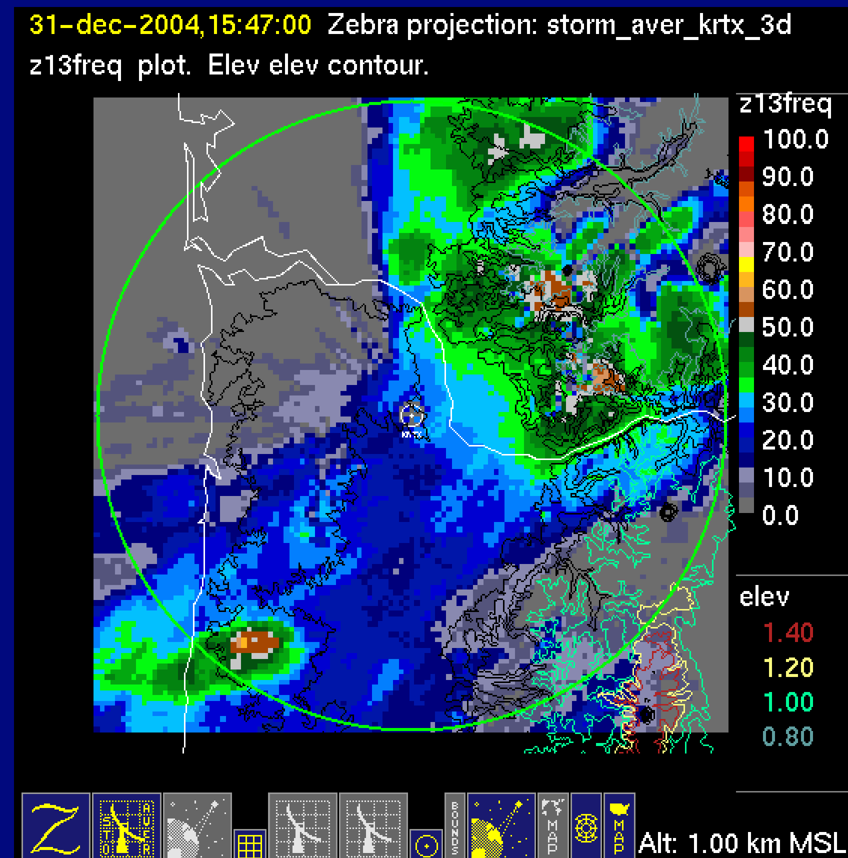
3.0 km altitude

31 Dec - 1 Jan storm

Wind Field
(radial velocity)

Freq. of Echo ≥ 13 dBZ





1.0 km altitude

31 Dec - 1 Jan storm

Wind Field
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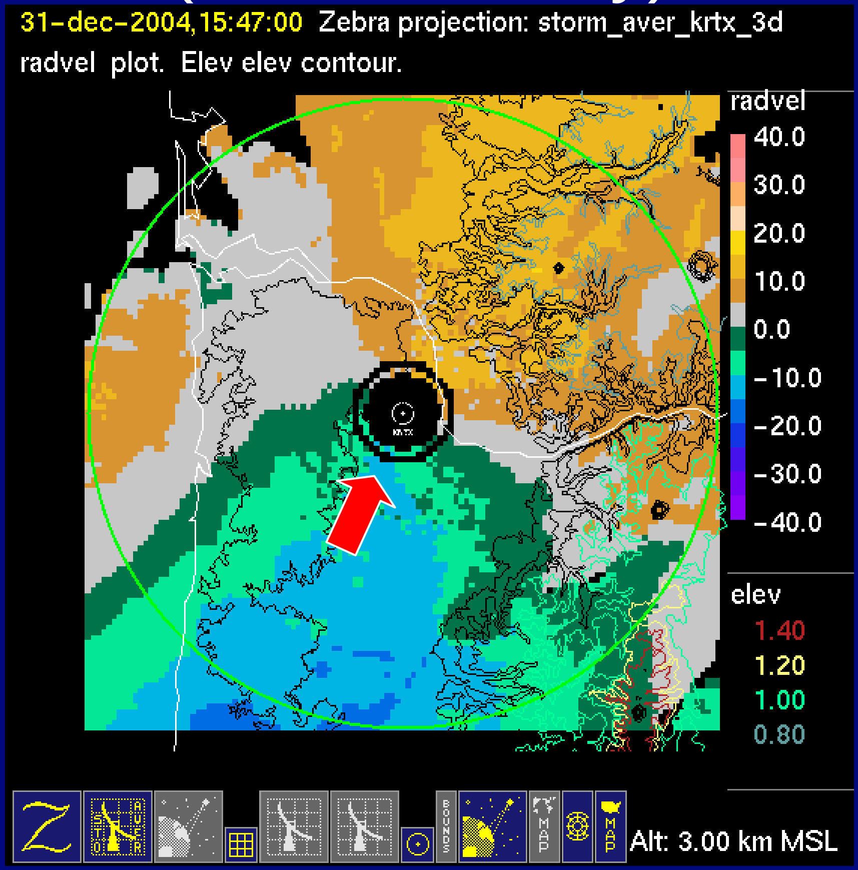
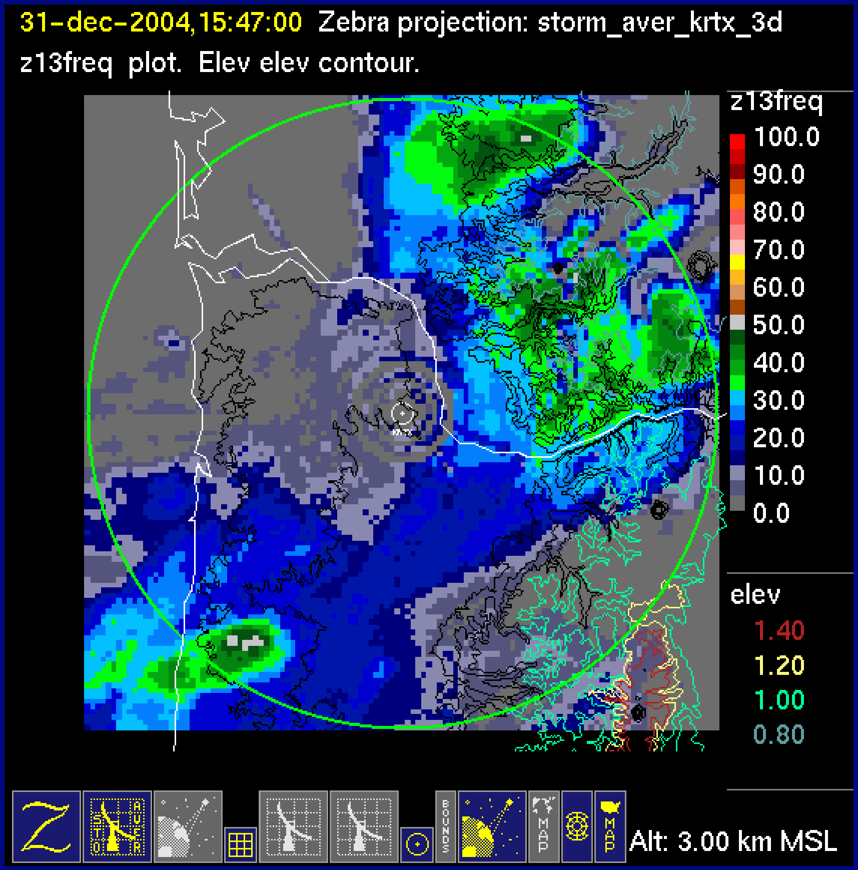




3.0 km altitude

Conclusions

- Orography limits radar's visibility, compare with model over subarea of domain
- Interpolate radar data to Cartesian grid
  - minimize range dependence
  - common coordinate system with model
- Variable freezing level height in winter complicates use of quantitative dBZ statistics

Suggested Observed 3D Characteristics for Forecasts of Winter Storms to Reproduce

From WSR-88D:

- Wind field pattern (radial velocity)
- Precipitation frequency pattern

From vertically-pointing radar

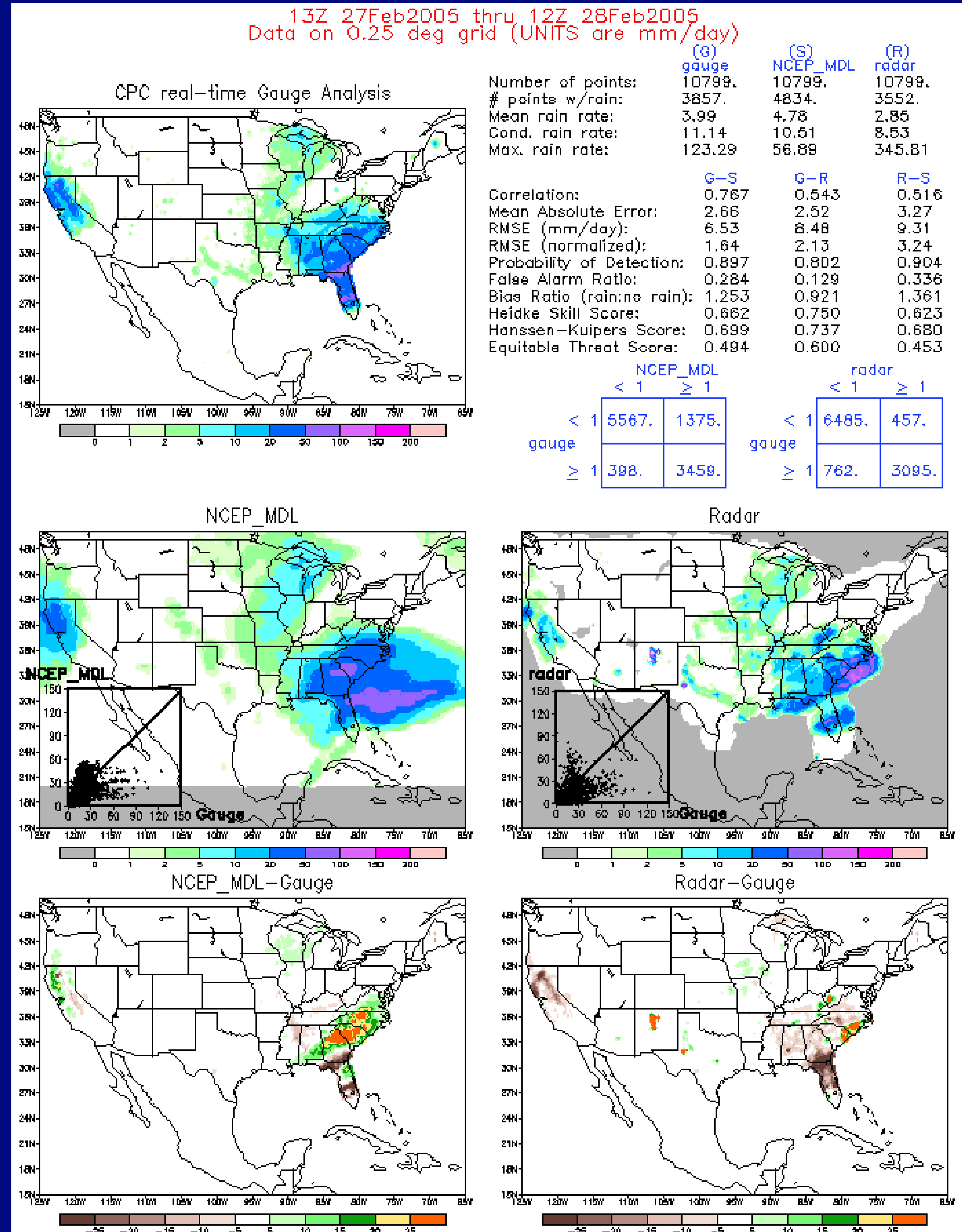
- Freezing level altitude (location, time)

The End

International Precipitation Working Group

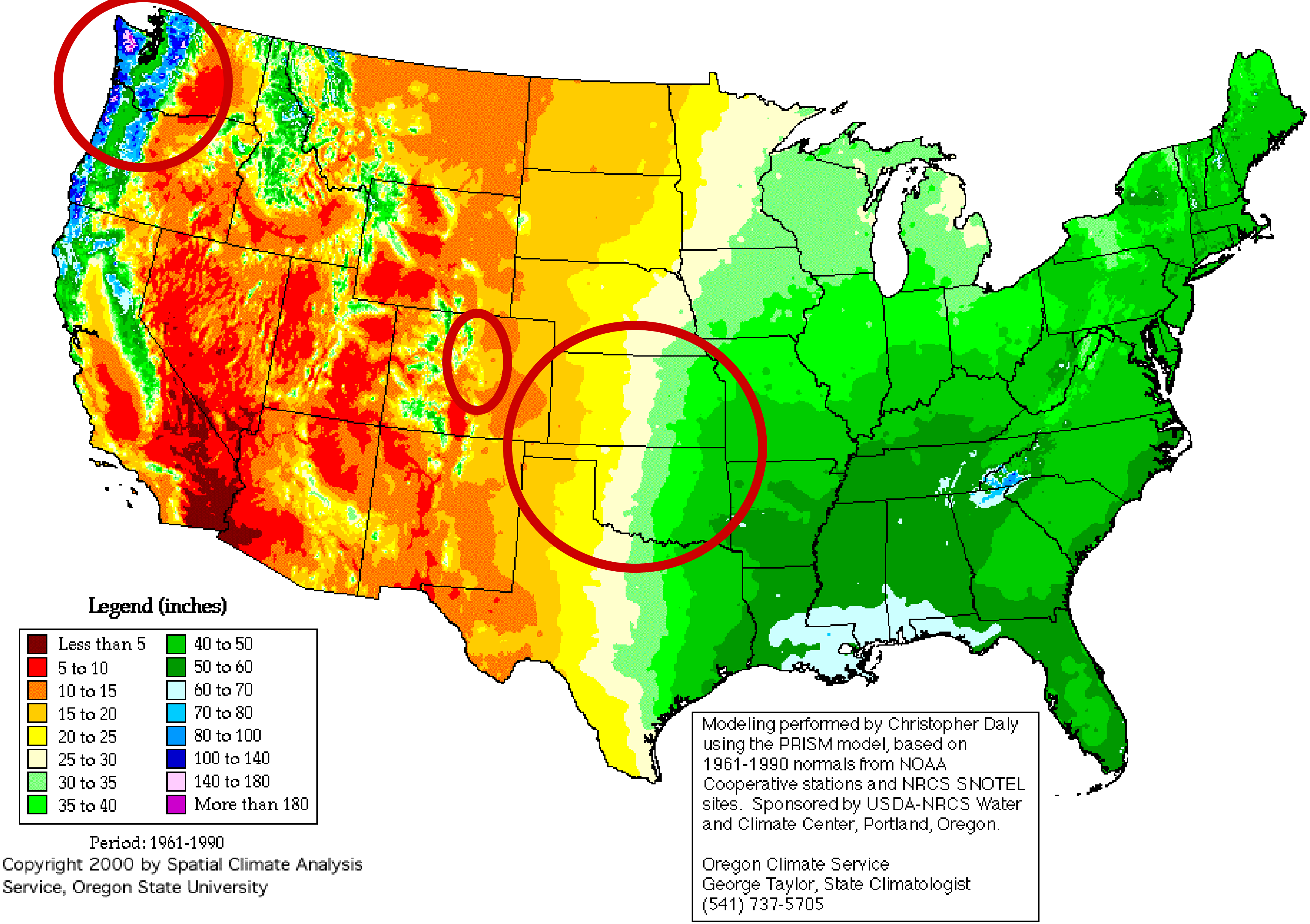
Sample of Daily Precip Comparison Product for CONUS

Web-accessible



Annual Average Precipitation

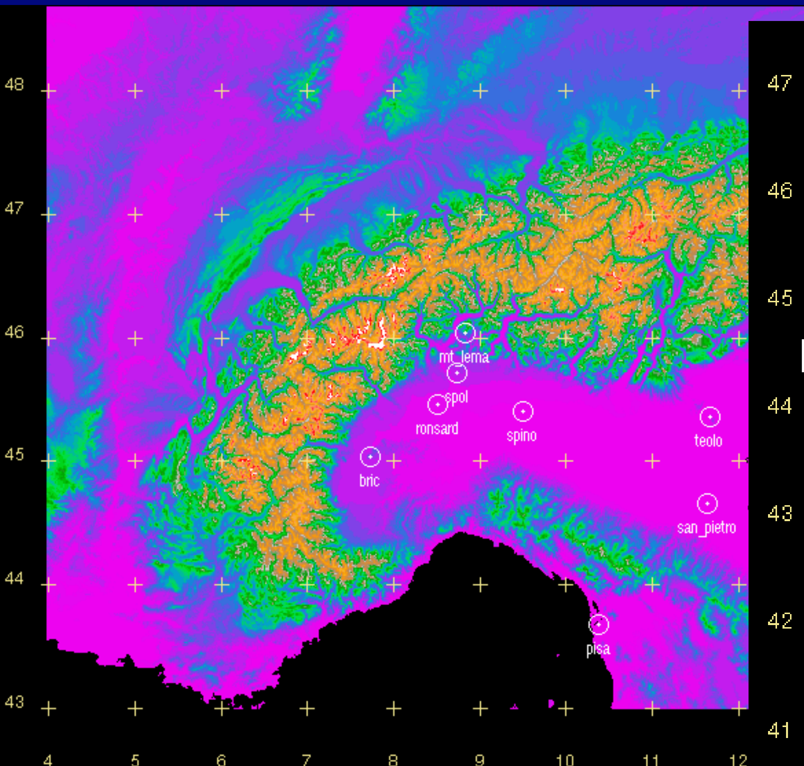
United States of America



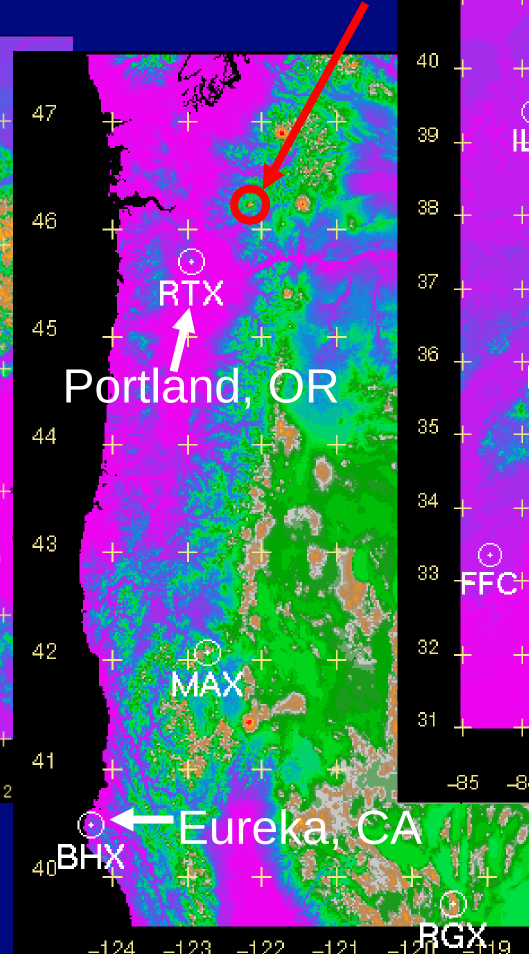
Period: 1961-1990

Topography Comparison

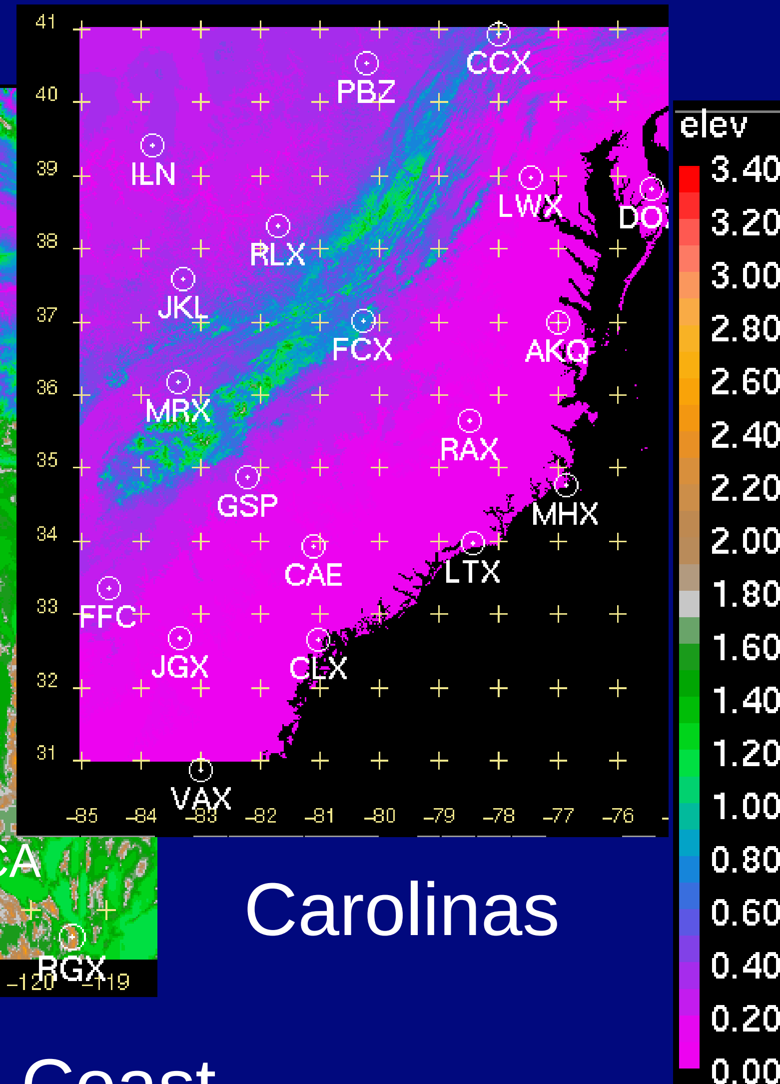
Alps



Mt. St. Helens



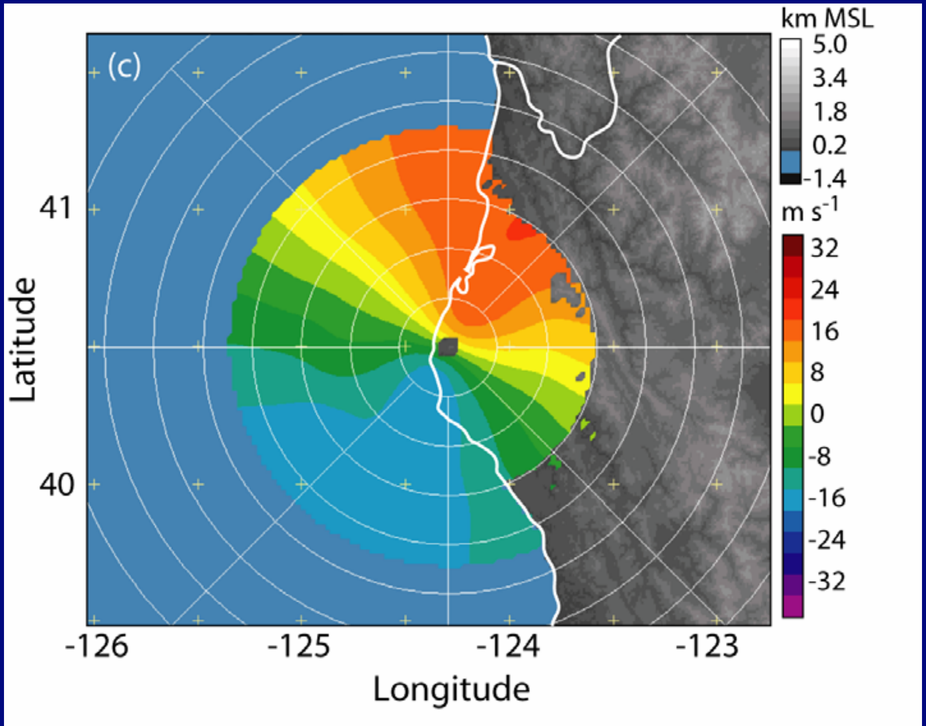
Central W Coast



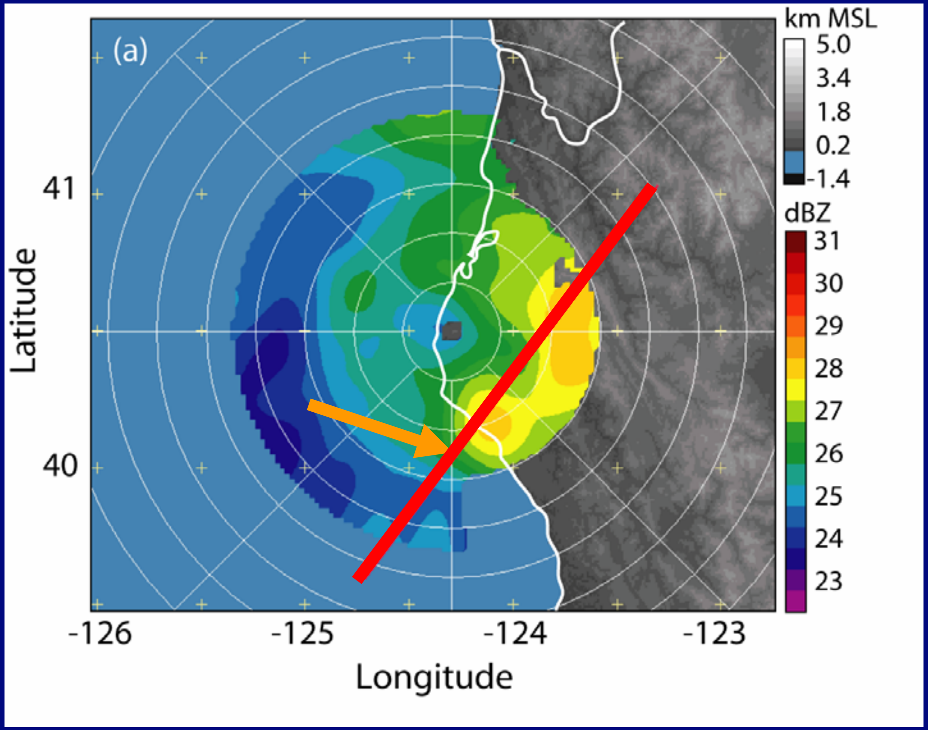
Carolinas

Mean Patterns for 61 Rain Events

Eureka, CA WSR-88D radar Oct 1995 – March 1998



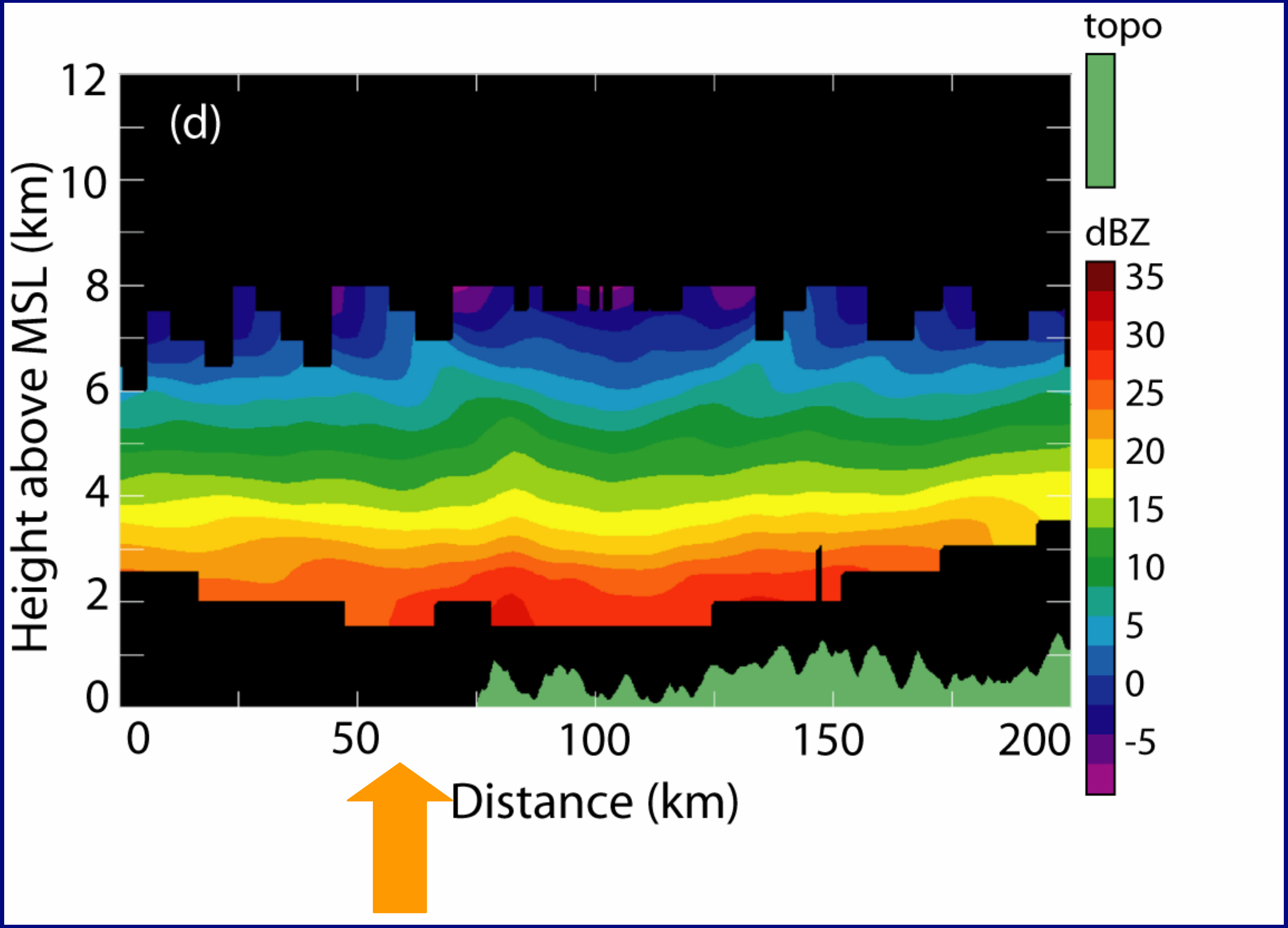
Mean Radial Velocity



Conditional Mean Reflectivity

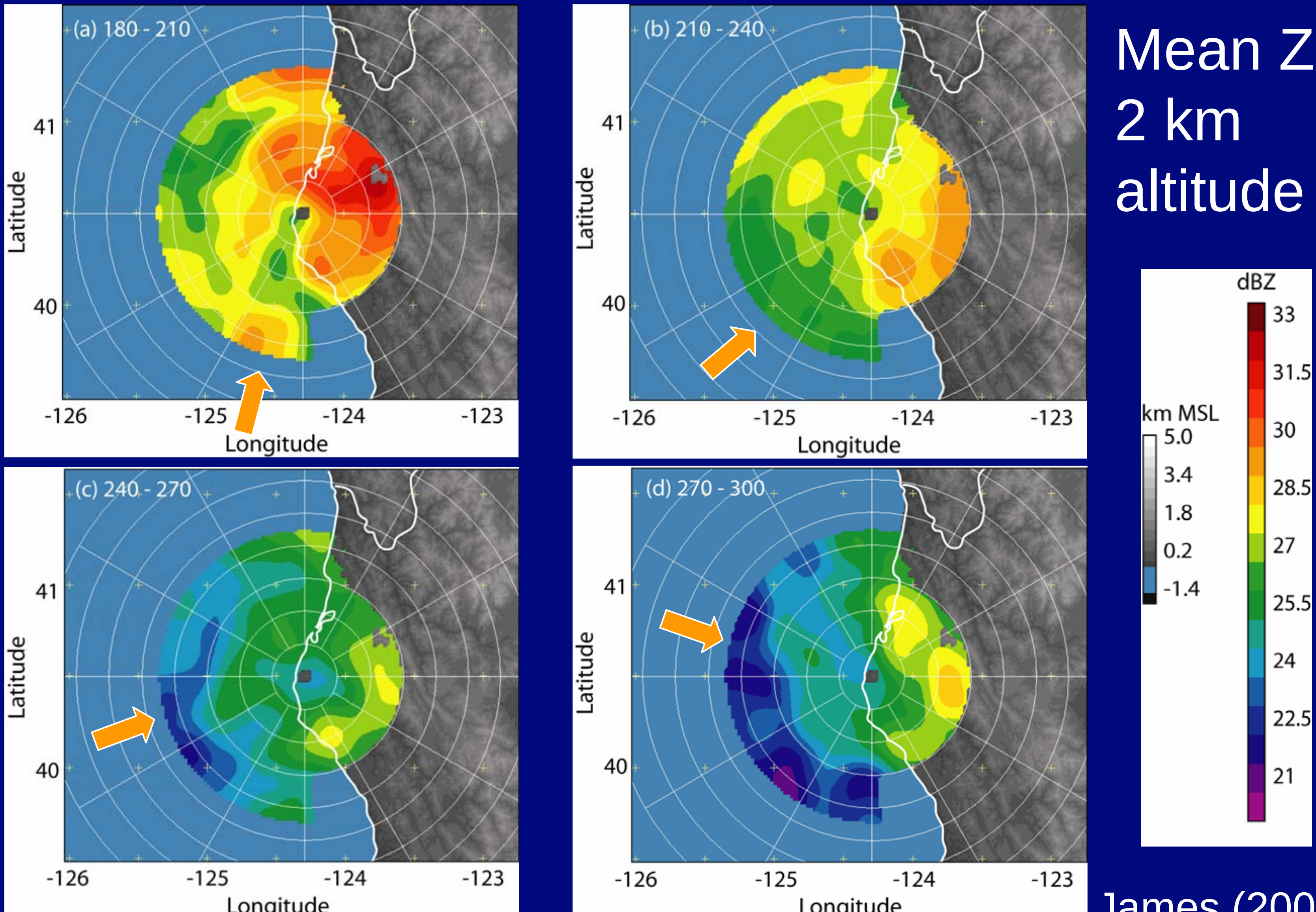
From James (2004)

Mean Reflectivity Cross-Section



Enhancement of precipitation over ocean upwind of coastal mountains (James, 2004)

Different reflectivity patterns for different wind directions



Mean Z
2 km
altitude

James (2004)

Radar-derived precipitation products

- Existence, Precip.Area--Min. detectable surface precip rate
- Classification of precip structure in vertical and horizontal into rain, snow, mixed, graupel/hail
- Spatial pattern of precip. intensity
- Quantitative estimate of precip. intensity